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DESIGNING A COMPONENT OF INFORMATION TECHNOLOGY OF STRAIN-GAUGE EXPERIMENTAL RESEARCH

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Components (information, program, technical information) technologies of strain-gauge experimental research of models of flight vehicles in the wind tunnels, realized on the basis by means developed by authors and methods and as their suitability and efficiency for the solution of design problems is shown, are considered.

Introduction

Realization of information technology (IT) of strain-gauge experimental researches (ER) in a wind tunnel (WT) demands creation its component (information, program, technical) [1].

In activity there are considered components IT strain-gauge ER models of flight vehicle (MFV) in the fuel flow control units realized on the basis before a means developed by authors and methods [2; 3], and also there is shown suitability and efficiency of the big angles of slide for the solution of design problems by the example of probe of aerodynamic coefficients MFV in conditions.

Statement of a problem

According to requirements to components IT strain-gauge ER MFV in a fuel flow control unit it is necessary to develop information, program, technical components on the basis of stated in [1] means and methods and there is shown their suitability and efficiency at the solution of design problems.

Information component

According to a designing method [1] and in view of results of the system analysis [2] it is offered to present all data as set technological B, experimental D and program Q data [3].

Thus B actuate parameters for control ER and the data used in processing ED. D are readings ABT, strain gauge (SG), etc. (actually ED). Q sets a timetable of activity of programs measuring-calculating system (ICS) and determines structure B and D:

$$\begin{array}{ccccc} B & \longleftrightarrow & P & \longleftrightarrow & D \\ & & \updownarrow & & \\ & & Q & & \end{array} \qquad (1)$$

where P – plan ER (PE).

On fig. 1 it is shown unified columns of sequence of processing of the information in IT according to new technology strain-gauge ER [1].

In tops ("information units") of information the column there are located information "documents". Its arches determine attitudes of "entering" and "sequence" between documents. Information columns determine kinds of information conversions which should execute IT strain-gauge ER, namely:

– creation of data sets - $\{x_i\}_{i=1}^{9}$-O_1–B_1–Y_1–E_1;

– replication ED in DB WS {B_1-B_2, B_1-B_3, B_2-B_3 - arches in fig. 1};

– primary, secondary processings ED, visualization and a storage Y_2-$\{O_i\}_{i=5}^{6}$-B_3–E_3–Y_3;

– set ED, their preliminary processing and display in rate ER {x_{10}, x_{11}}–O_2–B_2–E_2;

– documenting, visualization ED and their accommodation in archive Y_3-$\{O_i\}_{i=6}^{8}$-B_4–E_4-Y_4;

– diagnostics ICS x_{12}–O_3–E_2;

– performance ER {x_{10}, x_{11}}–O_2–B_2–E_2–Y_2 (the algorithm, is stated in [2]), etc.

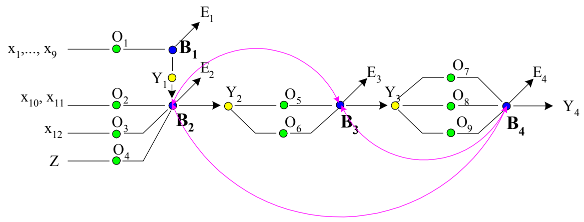


Fig. 1. Columns of information torrents:
Z – ED, received earlier, and located in a database (DB); x_1 – PE; x_2, …, x_9 – parameters of elements MFV (a wing, a power plant, etc.), modules ISC, equipment WT, SG, etc.; x_{10}, x_{11} – "zero" and "legal" ED; x_{12} – parameters of diagnosis and testing; O_1 – formation of characteristics MFV, ICS and conditions ER; O_2 – pretreatment ED; O_3 – operative control ICS and a fuel flow control unit; O_4, O_5 – primary and secondary processing ED; O_6, O_7, O_8 – preparation of diagram, texts and data for the information retrieval system (IRS); Y_1, …, Y_4 – output data workstation (WS) of the experimenter master on ER, operators on processing ED and on preparations of days off documents; B_1, …, B_4 – a DB of the experimenter master on ER, ED, output documents; E_1, …, E_4 – visualization ED on WS the experimenter master on ER, operators on processing ED and on preparation of documents

On the basis of development of a DB which is used for storage ED it is put conceptual model of the data (fig. 2) [3] which corresponds to relational model of data database management system (DMS) [4].

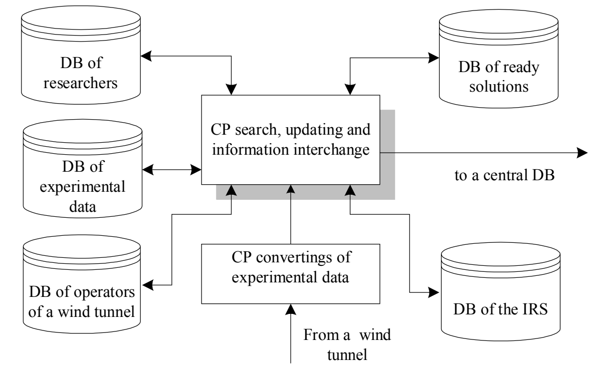


Fig. 2. Conceptual model of a DB

The accepted designing principles of information components IT define its conceptual model (fig. 3) as a set of logically connected DB (DMS) [2].

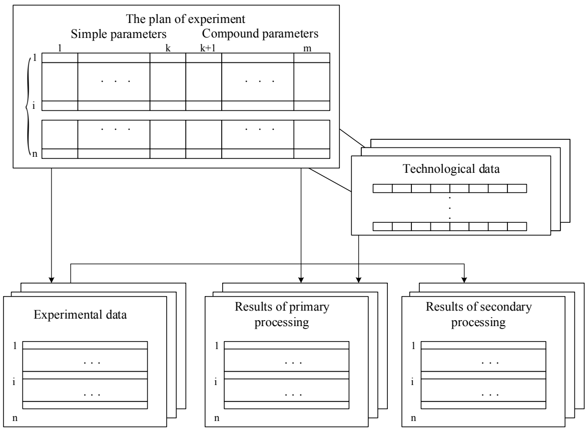


Fig. 3. Conceptual model of information environment

Distribution of a DB on units of the network (C-net) depends on type of the information kept in them: local (operator WT, the researcher) settle down on WS, popular (ED, target documents, the IRS) – on servers [4–6].

IT Algorithm [1] assumes, that in a DB of WT operators (fig. 3) are kept ED and results of initial processing which after termination ER are located in base ED, and used by researchers at the decision of design problems (a DB of researchers). The accepted decisions (tables, schedules, texts, etc.) are located in DB of ready decisions (documents) and the central DB what is used for the solving of the subsequent design problems.

The information is storekept in a DB of the IRS about executed ER.

The analysis of the information has shown [4], that ways of its storage and means of processing of the information of a DB should be various (fig. 3). Therefore, the DB for storage (1) is offered for realizing as file because they have small volume of local information (~1 Gb) which can be destroyed in part in process ER.

For management of such DB it is offered to use a separate complex of programs (CP) which has no universal properties DMS, but allows to operate with of files and data (accumulation, storage, search, etc.) effectively [3].

The DB of ready decisions (documents) should be always accessible to the central DB and the IRS. For their service it is offered to use DMS which allow, both to process and keep the data, and to form SQL-inquiries, to be connected to the removed server, etc. [7]. The basic criteria of their choice is as follows: support of relational model of the data, access to the removed servers, means of SQL-inquiries, collective access to the data, protection of the data, productivity, volumes of the processable information.

The analysis of information IT has shown, that its archive is expedient for organizing on compact discs which are transportable, universal, high-speed, volumetric, are steady against mistakes, inexpensive, are used on all types WS [8].

The question on formats of documents (reports, tables) has been investigated, and has been shown [9], that application of a format *.txt is the most effective. For example, transfer *.txt files instead of *.doc w97/w2000 on the C-net reduces loading up to 8 times. It is shown what to raise efficiency of use of a liaison channel it is possible by application, both equipment rooms, and program methods of condensation [10].

As a result the algorithm of processing of the information in IT strain-gauge ER MFV (fig. 4) where for maintenance of the rules of motion of documents on every WS of expert the personal task is located has been offered and its access to that part of the information on others WS which is necessary for fulfilment of the task is provided.

Selection DMS is designed according to offered procedural model [7] on the grounding of characteristics relational DMS [4].

In result it is possible to assert, that for IT strain-gauge ER MFV it is possible to use such DMS:

– file (see conceptual models on fig. 2 and 3);

– universal DMS Access (a DB of documents) and Clliper (IRS) [4; 11].

For preparation of reports and formation of information forms of the IRS it is enough to use editors (for example, MS Word, FotoEditor), and to transfer paper documents in electronic – a system of recognition of texts FineReader. In result according to solutions offered above new DB (fig. 4) which is used on WS the operator of a fuel flow control unit, the researcher master on ER and on a central server are organized. These DB represent sets of the interconnected files where are kept D (*.exp), B (*.kzt) and Q (*.izt).

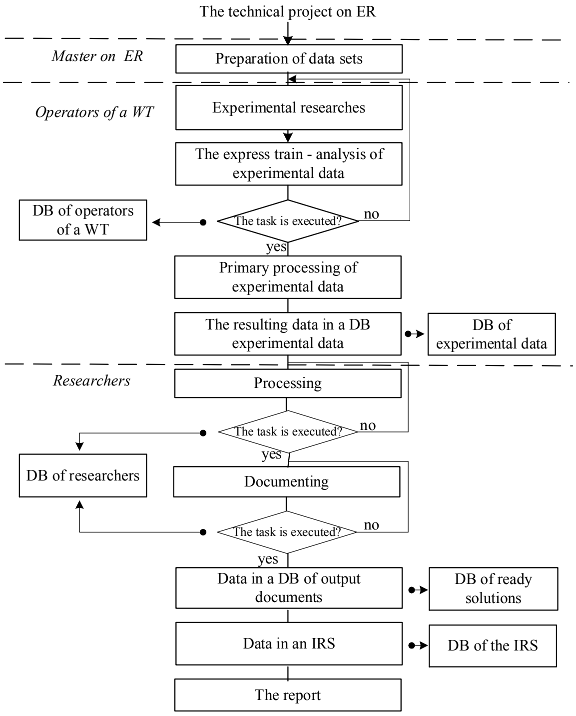


Fig. 4. The scheme of information streams

In process ER on WS by means of Excel express train - analysis ED and is executed, at presence of essential errors their updating.

Access to *.exp to files implements on their names. Records in *.exp files are used for primary processing ED - conversions of readings aerodynamic balance tensiometric (ABT) and SG in physical values (for example, forces and the moments).

The files of such data (Ωi) are located in DB ED and are kept before termination ER particular MFV.

Record ED in a DB is executed only after definition $\bar{\Omega}$ in checkpoints and checks of their correctness. For fulfilment of other kinds, these processings ED are located in local DB.

Results ER are submitted in documents (texts, tables, diagrams), with use of SQL-inquiries DMS Access [11; 12] are located in a DB of ready solutions on a server.

Information cards of the document are located with means Clliper in a DB of the IRS. Located on WS client parts DMS Oracle allows to receive the necessary design information a central DB.

Also users IT among themselves can communicate by means of E-mail.

Program a component

Program component IT strain-gauge ER MFV (actuates a system and applied software) it is designed according to offered in [2; 7] methods, and provides:
– resource management of the C-net;
– information interchange between units of the C-net (network functions);
– steady and a reliable operation of an applied software (service functions);
– fulfilment ER;
– functioning CP.

The analysis of these functions in view of specificity of technology strain-gauge ER has shown, that resources of the C-net are necessary for steering is centralized, and to suppose access WS to resources each other. These requirements also determine structure and a structure of network OS [13].

The analysis of possible logic models of interaction of software has shown, that for the basis of model of interaction of computing resources IT it is expedient to accept technology "client - server" which assumes fulfilment of applied problems both on WS, and on a server.

General reliability of a computer system in this case is higher, as a server is steader to failures in comparison with the personal computer.

Besides, requirements to WS become simpler, that allows using in their quality of the personal computer [1; 3].

For maintenance of reliability, stability IT and effective distribution of server functions, it is offered to unite servers of a DB, appendices and a server, balancing loading in cluster [8].

Network software IT should provide such kinds of service:
– protection against the non-authorized access;
– function of E-mail;
– file service;
– administration WS;
– access to the circumferential equipment;
– fulfilment of functions of the virtual terminal etc.

Thus exclusive processes are problems of steering ER and express train – analysis ED. Setting of service means of testing of a software and ICS, archiving and stand-by copying ED, recognition of viruses, etc. is obligatory. On WS CP provide both fulfillment of applied processes, and their interaction. For the organization of interaction between WS it is offered to use the C-net of bus topology Ethernet [8]. For protection of the information in the C-net it is offered to use, both equipment rooms (an electronic key), and program (password access) means of protection [8; 14].

The system software is chosen according to procedural model [7] and in view of the generated set of requirements [2]. It has been shown, that in IT it is expedient to use such software:
– network OS Windows'NT [13] which has means of protection of the information from the non-authorized access, reliable service of files and seales, supposes use of several servers and on a number of key parameters (reliability, service, devices, accessibility, etc.) surpasses other OS;

– network software PathWorks for support of relation "client – server";
– OS Windows'X which actuates set of drivers of external devices;
– environments of programming C ++, Delphi, Masm, etc. which are comprehensible to development of an applied software [15].

Realization of unified applied software is executed as combination applied CP which are integrated with packets Excel, MathCAD, Origin, according to specialization WS (fig. 5).

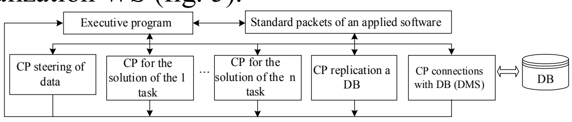


Fig. 5. Structure of applied software

Thus CP are independent of input and output, have modular structure and are created on the basis of modules of libraries SSP, SSL, etc. It provides unification of applied software [2; 3; 16].

Functionally applied software provides realization of three main groups of tasks:
– steering strain gauge ER in real time (RT);
– processing ED;
– documenting ED.

The first group of tasks is decided on WS operators of the fuel flow control unit, the second and the third–on WS researchers. As within the limits of each of these groups, WS functionally identical tasks the applied software is set up at installation that allows changing functionality of everyone WS within the limits of group are decided. Generalizing the scheme of an applied software it is shown on fig. 6.

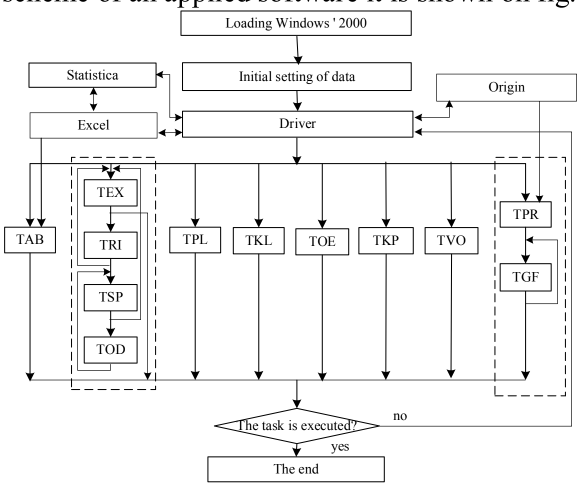
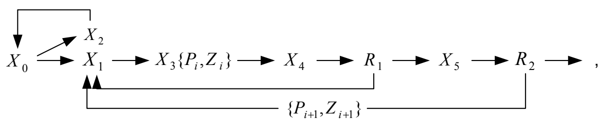


Fig. 6. Structure of applied software:
TKP – preliminary treatment ICS, equipments of a fuel flow control unit, ABT and SG; TKL – adjustings ED; TEX – steering and preliminary treatment ICS, pick up and records ED in a DB; TOE, TVO – primary and secondary processing ED; TPR – documenting; TAB – activities with data (1), mathematical models (MM) ABT and SG; TGF – graphic processing ED [1-3]

Start of applied software on WS is executed automatically at loading OS, and steering is transmitted to a driver interacting to the user by means of the WIMP-interface. For example, on WS the operator of a fuel flow control unit such functional tasks are decided:
– steering of the equipment and a stream of a fuel flow control unit;
– preliminary treatment ICS and the equipment of a fuel flow control unit;
– definition of MM ABT and SG;
– assemblyED and the express train – analysis;
– primary processing ED.

The applied software of these WS contains such CP: TEX, TKO, TKP, TOE, replication (ED in a DB of a server, and data (1) from local DB), Excel, Statistica, etc. CP TEX will consist of the program (fig. 6) TRI-steering ED, TOD-reading ED with ABT and SG, TSP-steering ICS, its algorithm actuates such operations [3]:



where X_0 is start CP and loading of initial data; X_1 is mode selection (preparation to ED, realization ER); X_2 is selection PE; X_3 is selection of experience from PE Pi, preliminary treatment ICS, input of parameters Zi; X_4 is reading and express train-analysis ED; X_5 are record ED in a DB; R_1, R_2 are criteria of quality ED.

Access of the researcher to ED allows to analyze, reveal operatively them errors in ED and to repeat experience before removal MFV from a fuel flow control unit.

By incorrect activity of the equipment of a fuel flow control unit, ICS are, etc. injected corresponding messages (for example, “an error in the port xx”, etc.), that guarantees reliability ED. Thus Excel as the component of applied software, is used for express train-analysis ED, and Statistica it is used for definition of MM ABT and SG [17].

On WS the researcher it is established CP with such functions:
– preparation of initial data ER (PE, data (1), etc.);
– secondary processing ED;
– graphic processing;
– the analysis and documenting ED (graphic arts, tables, texts).

The applied software of these WS contains CP TKL, TPR, TAB, TVO, Excel, Origin [17], Statistica, replication in a DB, client modules DMS Clliper, Access, Oracle.

Unified algorithm of activity of an applied software on WS are as follows:

$$\to S \to Z \to C \to R_1 \to \{M_0\} \to \{M_i\} \to \{X_0 \to X_i \to Y_0 \to Y_1\} \to R_2,$$

where S is start of OS; Z is loading of data (1); C is diagnostic ICS; R_1 is result of preliminary treatment ICS; M_0 is the main menu of an applied software; M_i is the menu of a *i* tasks; X_0 is CP for control ED; Y_0 is DMS/ CP; Y_1 is CP for replication DB; X_i is CP for realization *i* tasks; R_2 is criterion of quality of activity of an applied software.

Technical a component

Designing technical components IT strain-gauge ER MFV in a fuel flow control unit is executed according to an offered method in view of specific features of given kind ED [1], and it provides:
– a stable running of the C-net;
– the adaptive control over steering ICS, a fuel flow control unit and MFV;
– preliminary treatment ICS with registration and the signalling of deviations of parameters from preset values, emergency switching-off and returning in an operating mode after elimination of failures, etc.;
– pick up with primary source information (PSI) analog indications, their digital coding and registration;
– drive ED on information channels and on the C-net;
– visualization ED and results of their processing; reliable storages ED.

Conditionally these functions can be divided into three classes:
– service ER;
– support of activity of the C-net;
– interaction of users in the C-net.

These classes of functions as a hierarchical system with three levels are realized:
– the first – the equipment of a fuel flow control unit, ICS, etc.;
– the second – WS (in a control cabin of a fuel flow control unit, in laboratory), the C-net;
– the third – computing cluster.

The primary goal of hardware I of a level is steering ER, pick up and drive ED.

At II level, the tasks connected to processing ED are decided.

At III level of the hardware are intended for realization of functions of designing of aircraft.

Such structure supposes escalating the hardware as across (expansion of functions), and on a vertical (escalating of number of levels).

The unified structure technical components IT is shown on fig. 7.

Thus, ICS contains the divided control loops and measurements, and supports the automated obtaining the information directly from a fuel flow control unit, its transformation, drive, processing, storage, visualization and drive to the C-net [1–3; 6; 18].

The analysis of modern hardware-software platforms VME/VXI, PC/104, MicroPC, ADAM, etc. has shown, that offered structure IVS can be realized as the distributed system in standard MicroPC or VME (fig. 8).

In this case questions of unification, standardization are decided, expenses for support of its functioning and time of development decrease [20].

ICS will consist of standard industrial modules, has the normalized metrological characteristics and the common operation algorithm.

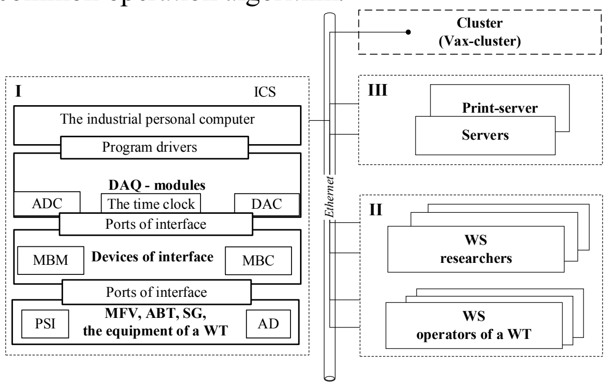


Fig. 7. Structure of technical components:
DAC, ADC – digital-to-analog and an analog – digitizer; MBM, MBS – matching boosters of measurement and steering; AD – actuating devices

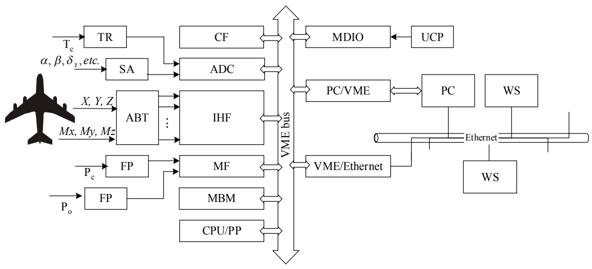


Fig. 8. Block diagram ICS:
TR – resistance thermometers for definition of temperature of deceleration of flow T_0; CF – the generator of clock frequencies (sets the period of a discretization of measurements); MDIO – a module of a discrete input/conclusion; UCP – units of calibration pressure (for calibration dataway); SA – sensors of an angle ($\alpha, \beta, etc.$);PC/VME – the controller of communication of tire VME from the personal computer; IHF – the interface of high firmness for SG; FP – the frequency pressure control device for definition full p_0 and static p_c pressure of a stream; MF – a multichannel frequency – digital module; MBM – a module of buffer memory (for accumulation ED); CPU/PP – a microprocessor control package of the assembly and processing ED

It takes into account specificity strain-gauge ER and provides required accuracy, response (50 meas./s, noise immunity (80 db), a plenty of controllable parameters.

ICS has united in a unified cycle of fulfilment of tasks of the assembly, processing, storage and documenting ED. At measurement (fig. 8) forces *X,Y,Z*, the moments M_x, M_y, M_z signals from ABT, SA, SG are simultaneously registered by group integrating ADC (an input range ±20mV…±2,5V, gain from 1 up to 128, source voltage SG 5 and 10 V, word length ADC of 16-24 bats, passband of the digital filter 2,5–270 Hz (it is set program putting), speed of updating of data from 10 Hz up to 1 kHz, an adduced error no more 0,03%).

Quality ED basically is determined accuracy of measurement of parameters of a stream – measurement full p_0 and static p pressure (Mach number M_∞ and drag is determined q). For this purpose are applied vibrofrequency FP (a range from $1{\cdot}10^3$ to $5{\cdot}10^5$ Pa, absolute error up to 10 Pa, relative – no more 0,05%), signals from which will be transformed to a code MF (quantity measuring channel - 8; capacity of counters – 2^{32}; a range of measurement 0,5–50 kHz; time of measurement from 0,01 up to 4 s; resulted error ±0,001%).

An error of definition of number M_∞ no more than 0,002. Maximal time of definition of parameters of a stream less 0,05 s.

ICS has a number of such advantages:

– a simultaneity of measurement of forces, the moments and parameters of the stream, reducing influence time-dependent a stream on accuracy of definition of aerodynamic coefficients;

– effective suppression of dynamic components by a digital filtration of signals from ABT in the converter;

– high resolution;

– accuracy of measurements.

In ICS which actuates modules VXI-AO-48xDC (program-controlled current sources), VXI-SC-1102 (the filter of low frequency), DEMUX-24x192 (current the demultiplexer), are used SG [20] connected on the four-wiring scheme to ICS. The given interface allows creating up to 24 ports with a power of strain-gauge bridges by the distributed pulses of a current, which essentially increases accuracy of measurements at full automation of process of measurements (see the scheme in [18]). Each module VXI-AO-48xDC contains 24 pairs software programmable independent current sources from 0,1 mA up to 20 mA. Demultiplexer DEMUX-24x192 consistently switches 24 pairs of current sources on 192 two-wire current ports of a power resistive-strain bridges. Operation control of the interface and processing ED implements the external personal computer.

Hardware modules and measuring channel; programs of the assembly and processing ED with ABT, sensors of parameters of a stream, angles of rule MFV, etc.; test programs. Connection between devices ICS is realized on relationship control ("commanders") and devices steered ("servant") with the help of commands according to the minutes of an exchange.

Complete set WS for support ER is executed according to their functional destination.

Volume hard drive is calculated from a condition of seating for them of an applied software, files of data and a DB [7].

As IT strain gauge ER MFV in a fuel flow control unit assumes graphic and text processing the information in the C-net corresponding devices are stipulated: the printer, plotter, the scanner, etc. It is offered to centralize input-output in the domain of the C-net by use of a separate server(fig. 9) [6; 8].

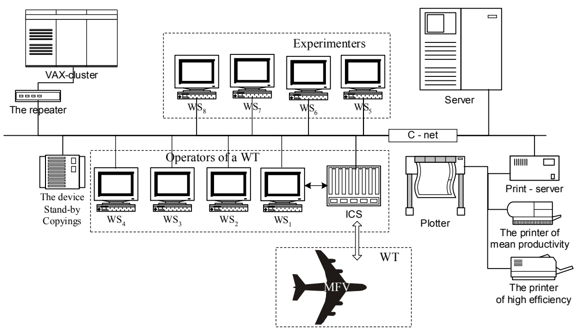


Fig. 9. Structure of the domain of the C-net

Rules of access to units of the C-net provide a capability of the reference{manipulation} to the general DB, and as indirect subordination WS that is caused by necessity of mutual use of resources separate WS [6; 8].

As model of interaction of the hardware it is offered to use two-tier architecture which at a hardware level is equivalent to model "client – server" where the server of appendices performs all computing activities, and a server of a DB – executes processing inquiries of users and processing of transactions [3].

Development of means of interaction of the user with IT is executed in view of decided functional tasks, information streams and groups of users. It is offered to apply dialogue, which combines the menu and standard forms according to the WIMP-standard [5]. For steering of an applied software it has three-level structure:

I – the level actuates functions on service ER;
II – the level actuates means of the solution of functional (CP);
III – the level is an ordinary dialogue of the solution of specific target II-го of a level.
Such structure of the menu is habitual for users IT, and at expansion of functions of applied software is modernized by addition of separate fragments [3]. As means of creation of applied software, it is offered to use modern environments of programming [15].
The analysis of requirements to resources technical components from the point of view of processes which are realized with the help of an applied software, has shown, that in IT strain-gauge ER MFV in a fuel flow control unit it is possible to use:
– the personal computer in quality WS;
– computer VAX-6000/9000;
– Hp-5000E (server);
– plotters GraphMaster;
– printers HP Laserjet (mean productivity) and Mopir (high efficiency);
– scanners Kodak;
– network adapters 3C501 firms 3Com Corporation;
– not shielded twisted pair UTP 5e as the relaying environment;
– multiport repeater DEMPR for connection ICS with the main segment of a C-net [3].
These devices have sufficient computing power, are compact, widely distributed also convenient in operation [1].
Realized technical a component allows:
– to organize parallel process ER;
– to unload servers, having transferred parts of activities on WS;
– to increase number WS;
– to provide an independent operation on WS on input, preparation and analysis ED.
The C-net supports:
– dispatch and obtaining of messages;
– an exchange of files;
– the centralized conclusion of the information on printers and graph plotters;
– use of the common hard drive;
– connection of the personal computer to computer VAX as remote terminals;
– fast and reliable transportation of files;
– E-mail;
– interaction between WS [3].

The solution of a design task

As a [21] results of the solution with use IT strain-gauge ER MFV in a fuel flow control unit of a design task of definition of aerodynamic coefficients of aircraft in conditions of the big angles of slide $\beta=0\div180^o$ and angle of attack $\alpha=\pm15^o$ are submitted.
ER in a fuel flow control unit of the AT-1 were conducted about use MFV 76MC200-001, setting of a circular blowdown, mechanical aerodynamic weights of AB-M2 and ICS.
As a result of executed probes it is shown [21], that:
– IT strain-gauge ER MFV in a fuel flow control unit allows to determine aerodynamic coefficients MFV with a relative error no more than 8 %;
– to process ED and to determine aerodynamic coefficients MFV in different coordinate systems;
– to determine MM ABT the methods stated in [2], that in a result confirms feasibility IT in design probes of aircraft.

Conclusion

1. Component IT strain-gauge ER MFV in a fuel flow control unit which designing is executedwith use developed in [2; 7] means and the methods, improved technology oriented on realization strain-gauge ER is offered versions of realization.
2. It is realized new problem-oriented IT, allowed to increase efficiency strain-gauge ER MFV in a fuel flow control unit due to drop of specific expenses, reduction of labour input, cutting-down of terms ER.
3. The analysis is executed and new structure ICS strain gauge ER MFV in a fuel flow control unit is offered because of modern modules of standard VME/VXI, and the generalized algorithm of activity IT strain-gauge ER MFV in a fuel flow control unit is developed.
4. The submitted results confirm efficiency IT strain-gauge ER at the solution design tasks. Thus terms of processing, the analysis and documenting ED are reduced and is saved labor the named operations.
In result on the grounding of methods [1; 2; 7] information, program and technical components IT strain-gauge ER MFV in fuel flow control unit which meet requirements showed to them are realized, and have allowed to expand functionalities, it is essential to increase self-descriptiveness process of obtaining of design solutions, to lower its labour input, and in a result to increase efficiency of design probes of aircraft.

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Проектування компонентів інформаційної технології тензометричних експериментальних досліджень

Розглянуто компоненти (інформаційний, програмний, технічний) інформаційної технології тензометричних експериментальних досліджень моделей літальних апаратів в аеродинамічних трубах, які реалізовані на основі розроблених засобів і методів. Показано їхню придатність і ефективність для розв'язку проектних задач

В.П. Зинченко, Н.П.Зинченко

Проектирование компонентов информационной технологии тензометрических экспериментальных исследований

Рассмотрены компоненты (информационный, программный, технический) информационной технологии тензометрических экспериментальных исследований моделей летательных аппаратов в аэродинамических трубах, реализованные на основе разработанных средств и методов. Показана их пригодность и эффективность для решения проектных задач.